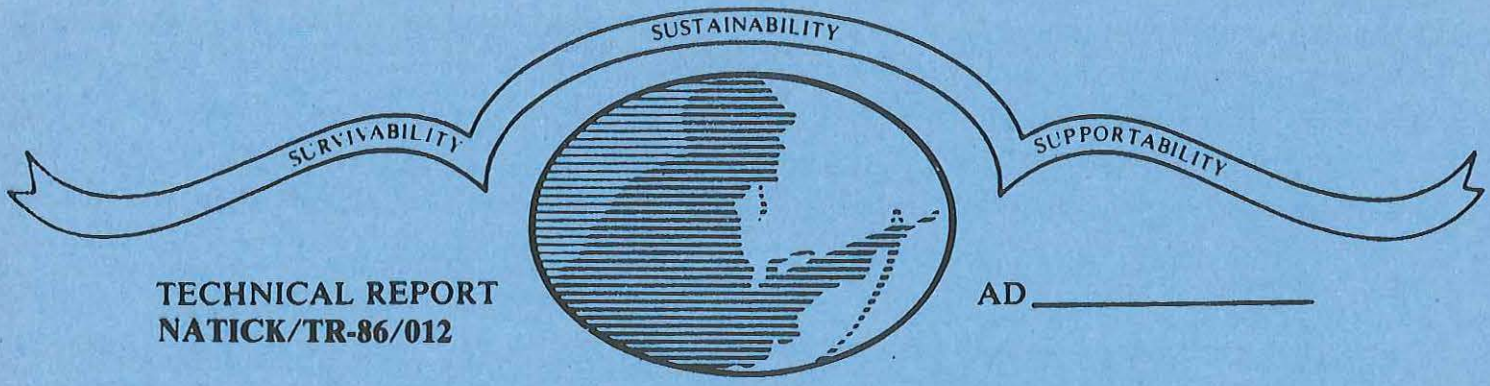

TECHNICAL REPORT
NATICK/TR-86/012

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AN EVALUATION OF FOODS PROCESSED IN TRAY PACK VERSUS TWO STANDARD FOOD SERVICE CONTAINERS

Part 2: Nutritional Analyses

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FINAL REPORT - 1976-1979

FEBRUARY 1986

UNITED STATES ARMY NATICK
RESEARCH, DEVELOPMENT AND ENGINEERING CENTER
NATICK, MASSACHUSETTS 01760-5018

FOOD ENGINEERING DIRECTORATE

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No 0704-0188
Exp. Date Jun 30, 1986

1a. REPORT SECURITY CLASSIFICATION: UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION / AVAILABILITY OF REPORT
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S): NATICK/TR-86/012	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION: Ration Design and Evaluation Branch, FTD, FED 6b. OFFICE SYMBOL (If applicable): STRNC-WTR	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (City, State, and ZIP Code): U.S. Army Natick RD&E Center, Natick, MA 01760-5018	7b. ADDRESS (City, State, and ZIP Code)
8a. NAME OF FUNDING / SPONSORING ORGANIZATION 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State, and ZIP Code)	10. SOURCE OF FUNDING NUMBERS

PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT ACCESSION NO.
AH99	1L162724	BC	031

11. TITLE (Include Security Classification)
AN EVALUATION OF FOODS PROCESSED IN TRAY PACK VERSUS TWO STANDARD FOOD SERVICE CONTAINERS
PART 2: Nutritional Analyses

12. PERSONAL AUTHOR(S)
Wyzga, Leslie A., Klicka, Mary V., Kubik, Christine A., Szczeblowski, Joseph W.

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Final	FROM 1976 TO 1979	February 1986	35

16. SUPPLEMENTARY NOTATION
This report is Part 2 of a two-part series. The subtitle to Part 1 is Sensory, Container and Bacteriological Tests (NATICK/TR-86/011).

17. COSATI CODES		
FIELD	GROUP	SUB-GROUP

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
Trays, Tray Packs, Cans, Cylindrical, Disposable, Nutrition, Pyridoxine, Equipment, Thiamin, Convection (Heat Transfer), Forced-Convection Oven, Water Bath Heating

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

In order to evaluate the effects of processing method and heating procedure on nutrient content, four different meat entrees were formulated and produced at the U.S. Army Natick Research, Development and Engineering Center, then packaged and processed frozen, in a Tray Pack and in a no. 10 can.

The objective of this study was to determine (1) the impact of the three packaging and processing variables on the nutrient content, (2) the nutrient losses which may have occurred when all entrees were heated for service, and (3) the differences between forced convection oven and water-bath heating on the nutrients available for consumption in the Tray Pack entrees.

The thiamin and pyridoxine retention in the Tray Pack entrees when heated were 52 and 73 percent of the corresponding precooked frozen entrees, while the retentions in cylindrical no. 10 can entrees were 26 and 56 percent, respectively. Moisture retention was maximized in the Tray Pack entrees in comparison to both the precooked frozen and no.10 can products.

20. DISTRIBUTION / AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION
22a. NAME OF RESPONSIBLE INDIVIDUAL: MARY V. KLICKA	22b. TELEPHONE (Include Area Code): AV 256-5102 22c. OFFICE SYMBOL: STRNC-WTR

DD FORM 1473, 84 MAR 83 APR edition may be used until exhausted. All other editions are obsolete.

(continued)

The forced-convection oven and water-bath methods of heat treatment were equally effective in minimizing pyridoxine losses.

PREFACE

This study was conducted in conjunction with An Evaluation of Foods Processed in Tray Pack versus Two Standard Food Service Containers Part I: Sensory, Container and Bacteriological Tests by R.A. Kluter, J.W. Szczeblowski and M.T. Branagan (NATICK/TR-86/011). This Part 2 report provides data on the nutritional content of four different entrees when stabilized by freezing, by thermoprocessing in a Tray Pack, and by thermoprocessing in a no. 10 can. The work was performed during the period 1976-1979.

This effort was undertaken to support the development of Tray Pack menu items, Combat Field Feeding System (CFFS), Project 1L162724AH99BC031, AMAFN 81-20(V), Packaging Developments for CFFS. To accomplish this work required the support of many people. The authors would like to thank the following for their assistance: Warren Roberts, Food Equipment Division, Food Engineering Directorate* (FED), who helped process and also heated test items and Margaret T. Branagan, Food Technology Division, FED and Bonita M. Atwood, Biological Sciences Division, Science and Advanced Technology Directorate** for submitting samples to the contract laboratory for analyses. The laboratory performing the nutrient analyses was Shankman Laboratories, Inc., Los Angeles, California under Contract DAAK60-79-D-0003.

The citation of trade names in this report does not constitute an official endorsement or approval of the use of such items. On October 1, 1985 the name of US Army Natick Research and Development Center (NRDC) was changed to U.S. Army Natick Research, Development and Engineering Center (NRDEC).

*Formerly, Food Engineering Laboratory
**Formerly, Science and Advance Technology Laboratory

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INTRODUCTION

Minimal cost, weight, cube, and refrigeration along with optimal acceptable food quality are essential criteria for components of a combat field feeding ration and influence its success or failure.(1) Many processed convenience foods meet with these requirements and have become widespread in garrison and field feeding systems. A newly developed rectangular can that is currently gaining popularity in both military and industrial feeding systems is the Tray Pack. A Tray Pack food is a shelf-stable food that has been thermostabilized in a retortable half-size steamtable pan with a double seamed lid.(2) Since these products are completely prepared and ready for serving from the package after heating, they are highly desirable for combat field feeding use. Tray Packs offer the advantages of rapid heating, little or no meal preparation labor, energy savings, easy cleanup, and reduced storage requirements. Furthermore, the container holds the same volume of food as the cylindrical no. 10 can and achieves commercial sterility in less than half the heat processing time required for a no. 10 can.(2)

In order to introduce Tray Pack foods successfully into military food service systems, R.A. Kluter, J.W. Szczeblowski, and M.T. Branagan conducted a 36-month study to compare sensory quality and acceptability of nine entrees, each of which was: (1) precooked, then packaged and frozen at -32°C (-25°F) in half-size, steamtable disposable aluminum trays with crimp-on lids, (2) thermoprocessed in Tray Pack containers, and (3) thermoprocessed in cylindrical no. 10 cans. This paper reports the nutritional data obtained on four of these entrees. Appendix A provides the formulas used for each entree.

This study was conducted to determine the impact of three processing methods - partial precooking and freezing, thermostabilization in a Tray Pack and thermostabilization in a no. 10 can on the nutrient content, the nutrient losses that may have occurred when all entrees were heated in a forced-convection oven for service, and the effect of heating in a water bath on the nutrients available for consumption in Tray Pack entrees. This investigation into method of heating was performed to obtain comparative nutritional data on Tray Packs prepared in garrison and field feeding systems, which utilize dry heat and water baths, respectively.

EXPERIMENTAL METHODS AND PROCEDURES

Three meat entrees (Chicken Cacciatore, Smoky Pork, and Swiss Steak) and one meat/pasta combination entree (Beef Burgundy) were formulated and produced at the U.S. Army Natick Research, Development and Engineering Center (NRDEC). Five replicates of each independent variable were used in this study as indicated below.

Independent Variables

1. Packaging Container and Processing Procedure
   a. Precooked frozen
   b. Tray Pack (thermostabilized)
   c. No. 10 can (thermostabilized)
2. Heating Treatment
   a. Forced-convection oven
   b. Water bath

The independent test variables for each entree included packaging container and processing procedure (precooked frozen, Tray Pack, and no. 10 can) and heating treatment (forced-convection oven and/or water bath). Each of these variables is described in greater detail below.

Due to the capacity limitations of the retort, both Tray Pack and no. 10 can items were heat processed in as many as three different lots. For each independent test variable of each test phase, five samples were randomly selected from the lots produced and then treated as one lot since the small sample size (N=5) did not permit further differentiation.

Packaging Container and Processing Procedure

Precooked/Frozen: Precooked product was packaged in half-size steamtable aluminum foil trays with crimp-on lids produced by ECKO Products, Inc. Entrees were then blast frozen at -32°C (-25°F) and stored at -18°C (0°F).

Tray Pack: Partially cooked product was hermetically sealed in a Tray Pack can constructed by Central States Can Company having S-9009-102 modified vinyl interior and S-9364-001 epoxy exterior coatings, and processed at 121°C (250°F) in a steam-air retort, with water spray cooling, to a commercial sterility minimum of F_o8. The time required for the thermoprocessing of Tray Pack and no. 10 can entrees in the retort is shown in Table 1.

No. 10 can: Partially cooked product was hermetically sealed in cans from the American Can Company having 4J Oleoresinous "C" enamel linings, and processed at 121°C (250°F) in a steam-air retort, with water spray cooling, to a commercial sterility minimum of F_o8. See Table 1 for processing times for the no. 10 cans.

Table 1. Thermoprocessing Time for Tray Pack and No. 10 Can Entrees

Entree	Tray Pack (minutes)	No. 10 Can (minutes)
Beef Burgundy	64	225
Chicken Cacciatore	70	232
Smoky Pork	62	223
Swiss Steak	60	224

Heating Treatment of the Three Packaging - Processing Methods

Five samples of each were heated in a 177°C (350°F) preheated General Electric Model CN90A forced-convection oven to an internal temperature of 75°C (165°F), determined by inserting a stab thermometer in the corners of the container. Before heating, the crimped-on lids of the aluminum trays containing the precooked frozen entree were loosened around the periphery and the lids of all hermetically sealed Tray Pack pans were pierced in nine places to vent steam. All no. 10 cans were opened and their contents were transferred to half-size, stainless steel steamtable pans that were covered with aluminum foil before being placed in the convection oven. Because Tray Packs are a component of field feeding systems that use water bath heating, five of each of the four Tray Pack entrees were heated unopened in a 82°C (180°F) water bath to an internal temperature of 74°C (165°F), as determined by the use of a thermocouple placed in the container prior to processing.

Nutrient Analysis

After processing or heating, samples were shipped frozen via air freight to the analytical laboratory* for analysis. All heated samples were frozen immediately after heating and kept frozen until prepared for analysis. In the analytical laboratory, samples were comminuted and assayed for nutrient content

*Shankman Laboratories, Los Angeles, CA performed the analyses under contract DAAK60-79-D-003 (unpublished reports).

according to standard methods specified in Appendix B. All vitamin, fatty acid and cholesterol analyses were performed in duplicate. Proximate and mineral analyses were conducted singularly. All five replicates of each test variable were analyzed for moisture, fat, and vitamin contents. Protein, ash, mineral, cholesterol, and fatty acid analyses were performed on three replicates of the unheated samples.

Statistical Analysis

The analytical data for each nutrient were analyzed using an analysis of variance (ANOVA) to evaluate the effects of the treatments on the nutrients. The Duncan Multiple Range Test(3) was used to determine where significant differences occurred. Differences obtained in this study are reported at the 95% level of confidence.

RESULTS AND DISCUSSION

Effect of Packaging and Processing on Net Weight and Nutritive Content

The net weight and nutritional content per 100 grams of product (as-is basis) in both the unheated and convection oven heated samples are provided in Appendix C. The total net weight losses are due to moisture evaporation during heating. Losses were minimal for Tray Packs because less moisture escaped. Tray Pack lids were not lifted at corners (precooked frozen) or transferred to a pan then foil covered by hand (no. 10 can).

Protein, Ash, Mineral, and Cholesterol Content of Unheated Entrees

A statistical comparison of the protein, ash, mineral, and cholesterol data obtained from chemical analyses of all unheated samples of each of the four entrees on a moisture and fat-free basis (Table 2) highlights the general uniformity of the protein, ash, and mineral contents of the precooked frozen, Tray Pack, and no. 10 can formulas after processing for each respective entree. The authors believe all of the differences in protein and mineral content represent sample or analytical variability rather than packaging or processing treatments effects.

Fatty Acid Content of Unheated Entrees

Comparison of the mean fatty acid values (as percent of total fatty acids) of the unheated precooked frozen, Tray Pack, and no. 10 can samples of each entree (Appendix D) showed clearly that the difference among the packaging/ processing treatments for all products were minimal. All differences are due to fat content variability in samples rather than to a treatment effect.

Table 2. Protein, Ash, Mineral and Cholesterol Content of Unheated Precooked Frozen, Tray Pack, and No. 10 Can Entrees
(Mean ± Standard Deviation Per 100 Grams of Product, *Moisture and Fat-Free Basis)

	Protein g	Ash g	Calcium mg	Phosphorus mg	Iron mg
Beef Burgundy					
Precooked Frozen	66.0 ± 8.2	7.87 ± 0.42	59 ± 2	630^{a} ± 22	10.03 ± 0.63
Tray Pack	62.0 ± 3.3	7.93 ± 0.53	71 ± 7	583^{b} ± 17	9.44 ± 0.88
No. 10 Can	54.3 ± 0.9	7.62 ± 0.20	70 ± 7	557^{b} ± 4	9.75 ± 0.58
Chicken Cacciatore					
Precooked Frozen	73.1 ± 3.0	7.58 ± 0.15	77 ± 3	436 ± 114	3.61 ± 0.87
Tray Pack	70.4 ± 3.7	7.30 ± 0.75	72 ± 4	564 ± 57	5.55 ± 2.19
No. 10 Can	72.0 ± 1.2	7.58 ± 0.22	86 ± 12	619 ± 29	3.84 ± 0.07
Smoky Pork					
Precooked Frozen	71.2 ± 1.0	5.64 ± 0.24	56 ± 6	569 ± 81	4.68^{c} ± 0.33
Tray Pack	76.1 ± 2.6	5.63 ± 0.11	65 ± 16	545 ± 91	6.01^{b} ± 0.48
No. 10 Can	79.2 ± 6.0	5.48 ± 0.14	54 ± 4	681 ± 14	7.91^{a} ± 0.62
Swiss Steak					
Precooked Frozen	86.9^{a} ± 2.6	7.14 ± 0.18	40 ± 1	738 ± 38	8.45 ± 0.24
Tray Pack	79.8^{b} ± 2.7	8.20 ± 1.24	49 ± 13	702 ± 86	9.19 ± 0.81
No. 10 Can	86.3^{a} ± 2.1	7.18 ± 0.55	45 ± 3	646 ± 48	8.99 ± 0.22

	Sodium mg	Potassium mg	Magnesium mg	Chloride mg	Cholesterol mg
Beef Burgundy					
Precooked Frozen	1995 ± 61	1218 ± 72	93 ± 2	3.76^{b} ± 0.07	234 ± 25
Tray Pack	2234 ± 184	1103 ± 59	89 ± 3	4.11^{a} ± 0.17	232 ± 31
No. 10 Can	2010 ± 41	1064 ± 115	87 ± 2	3.92^{ab} ± 0.01	192 ± 16
Chicken Cacciatore					
Precooked Frozen	1662 ± 178	1136 ± 27	95 ± 1	3.69 ± 0.17	193 ± 6
Tray Pack	1612 ± 215	1087 ± 96	92 ± 6	3.70 ± 0.19	169 ± 14
No. 10 Can	1724 ± 82	1122 ± 70	91 ± 2	3.77 ± 0.08	203 ± 24
Smoky Pork					
Precooked Frozen	1059^{ab} ± 34	1334 ± 16	92^{a} ± 3	2.19 ± 0.18	370^{a} ± 9
Tray Pack	1169^{a} ± 87	1235 ± 35	82^{b} ± 3	2.47 ± 0.12	347^{b} ± 6
No. 10 Can	1020^{b} ± 22	1331 ± 73	88^{ab} ± 4	2.18 ± 0.04	358^{ab} ± 8
Swiss Steak					
Precooked Frozen	1959 ± 112	1186 ± 62	87 ± 2	3.97 ± 0.19	288 ± 24
Tray Pack	2197 ± 376	1175 ± 172	88 ± 12	4.64 ± 0.64	284 ± 14
No. 10 Can	2089 ± 158	987 ± 110	79 ± 3	4.28 ± 0.32	309 ± 20

*Means for each food item within a column followed by different letters are statistically different ($P \leq 0.05$) as determined by the Duncan's Multiple Range Test.

Proximates and Minerals N=3 (analyzed singularly). Cholesterol N=3 (analyzed in duplicate).

Vitamin Content

In an effort to identify the deleterious effect of heat preservation upon nutrient retention, D.A. Greenwood, B.W. Beadle, and H.R. Kraybill investigated the "core effect."(4) In this condition, food nearest the can wall sustains excessive heat treatment before food in the center of the can attains commercial sterility. The magnitude of nutritional losses can be reduced by utilizing methods to minimize this undesirable effect. Use of the rectangular Tray Pack can measuring 313 mm long, 226 mm wide, and 51 mm deep (12 5/16" x 10 1/16" x 2") is one way to diminish the severity of peripheral overcooking.(5) Consequently, it was expected that the greatest vitamin retention would occur in the precooked frozen, with less retention in the cylindrical no. 10 can. As Table 4 shows, this hypothesis was correct.

Thiamin and Pyridoxine

Thiamin and pyridoxine were the two vitamins that consistently showed changes that could be directly attributed to the processing/packaging treatments. As expected, thiamin levels were consistently highest in the precooked frozen samples of each entree, next highest in the Tray Pack samples, and the lowest in the no. 10 can samples. As Table 3 and Figure 1 show, this pattern was true for all unheated and heated samples except that, due to low concentrations and large standard deviations, the difference between the heated Tray Pack and no. 10 can samples of Swiss Steak was not statistically significant.

The pyridoxine levels of all entrees demonstrated the same retention pattern as thiamin, with the highest levels found in the precooked frozen samples, the intermediate levels found in the Tray Packs, and the lowest levels in the no. 10 cans (Table 3 and Figure 2). However, the mean difference between the precooked frozen products and the Tray Packs was not significant for the unheated samples of Chicken Cacciatore and Swiss Steak, and the difference between the Tray Pack and the no. 10 can samples of heated Smoky Pork also was not significant.

In this study, the precooked frozen entrees represent the control products, i.e., those having optimum nutrient content. Therefore, the thiamin and pyridoxine content of each unheated and heated Tray Pack and no. 10 can entree is given in Tables 4 and 5 as a percent of the amount of thiamin (Table 4) or pyridoxine (Table 5) in each respective precooked frozen control. Compared in this manner (Table 4), the mean of thiamin content for all Tray Pack entrees was 62 percent of thiamin in the precooked frozen entree, and the mean of thiamin content for all no. 10 can entrees was 37 percent that in the precooked frozen entrees. After heating, the levels of thiamin in the Tray Pack and no. 10 can entrees were, respectively, 52 percent and 26 percent of the levels in their heated precooked frozen controls. When similarly compared (Table 5), the pyridoxine in levels of the unheated Tray Packs and no. 10 can entrees averaged 86 percent and 59 percent of the levels in the unheated frozen controls; after

Table 3. Vitamin Content of Unheated and Heated Precooked Frozen, Tray Pack, and No. 10 Can Entrees (Mean ± Standard Deviation Per 100 Grams of Product, *Moisture and Fat-Free Basis)

	Carotene mg	Ascorbic Acid mg	Thiamin mg	Riboflavin mg	Niacin mg	Pyridoxine mg	Vitamin B12 mcg	Vitamin E mg
Beef Burgundy								
unheated								
Precooked Frozen	NA	NA	0.16^{a} ±0.02	0.71 ±0.06	11.74^{a} ±0.91	0.87^{a} ±0.09	5.39^{b} ±0.51	4.5^{a} ±0.5
Tray Pack	NA	NA	0.10^{b} ±0.01	0.67 ±0.05	10.66^{b} ±0.70	0.72^{b} ±0.08	7.08^{a} ±0.27	3.0^{b} ±0.5
No. 10 Can	NA	NA	0.07^{c} ±0.01	0.62 ±0.04	10.26^{b} ±0.62	0.51^{c} ±0.04	5.82^{b} ±1.02	3.6^{ab} ±1.3
heated								
Precooked Frozen	NA	NA	0.16^{a} ±0.01	0.73^{a} ±0.01	10.86^{a} ±0.40	1.00^{a} ±0.11	5.83 ±0.56	1.9^{b} ±0.4
Tray Pack	NA	NA	0.10^{b} ±0.01	0.63^{b} ±0.03	9.50^{b} ±0.58	0.79^{b} ±0.11	5.30 ±0.50	4.0^{a} ±0.6
No. 10 Can	NA	NA	0.06^{c} ±0.02	0.62^{b} ±0.03	9.12^{b} ±0.90	0.53^{c} ±0.05	5.41 ±0.50	3.6^{ab} ±0.7
Chicken Cacciatore								
unheated								
Precooked Frozen	0.190^{b} ±0.018	11c ± 2	0.14^{a} ±0.01	0.45^{a} ±0.02	24.76^{ab} ±0.86	1.13^{a} ±0.09	2.58 ±0.25	1.7 ±0.5
Tray Pack	0.288^{a} ±0.056	30b ±11	0.08^{b} ±0.03	0.41^{b} ±0.04	25.30^{b} ±1.42	1.04^{a} ±0.14	2.26 ±0.17	1.3 ±0.3
No. 10 Can	0.244^{ab} ±0.034	44a ± 8	0.04^{c} ±0.01	0.36^{c} ±0.02	23.48^{b} ±0.50	0.74^{b} ±0.06	2.30 ±0.30	1.4 ±0.4
heated								
Precooked Frozen	0.296^{b} ±0.025	30B ± 8	0.11^{a} ±0.01	0.42^{a} ±0.02	25.90 ±2.04	1.07^{a} ±0.10	2.65^{a} ±0.01	2.1^{b} ±0.4
Tray Pack	0.310^{b} ±0.037	27B ± 4	0.06^{b} ±0.01	0.37^{b} ±0.04	27.14 ±0.70	0.75^{b} ±0.04	2.42^{a} ±0.04	1.9^{b} ±0.2
No. 10 Can	0.358^{a} ±0.015	47A ± 7	0.04^{c} ±0.01	0.35^{c} ±0.03	28.00 ±1.10	0.66^{c} ±0.03	2.01^{b} ±0.02	3.1^{a} ±0.1
Smoky Pork								
unheated								
Precooked Frozen	0.314^{a} ±0.026	NA	1.94^{a} ±0.09	0.94 ±0.08	15.30 ±1.01	0.93^{a} ±0.05	3.16^{b} ±0.22	2.3 ±0.4
Tray Pack	0.295^{a} ±0.018	NA	0.95^{b} ±0.13	1.00 ±0.04	13.88 ±1.38	0.68^{b} ±0.03	3.67^{a} ±0.20	2.1 ±0.4
No. 10 Can	0.261^{b} ±0.023	NA	0.55^{c} ±0.04	0.98 ±0.03	15.44 ±0.56	0.46^{c} ±0.03	3.85^{a} ±0.19	2.2 ±0.1
heated								
Precooked Frozen	0.345 ±0.041	NA	1.78^{a} ±0.18	0.84^{c} ±0.01	14.96 ±1.34	0.86^{a} ±0.10	2.57^{b} ±0.22	2.7 ±0.3
Tray Pack	0.382 ±0.062	NA	0.77^{b} ±0.11	0.92^{b} ±0.03	15.20 ±1.21	0.50^{b} ±0.11	3.35^{a} ±0.19	2.4 ±0.5
No. 10 Can	0.315 ±0.032	NA	0.36^{c} ±0.07	0.98^{a} ±0.07	17.12 ±2.19	0.42^{b} ±0.06	3.38^{a} ±0.40	2.8 ±0.6

Table 3. Vitamin Content of Unheated and Heated Precooked Frozen, Tray Pack, and No. 10 Can Entrees (Mean ± Standard Deviation Per 100 Grams of Product, *Moisture and Fat-Free Basis) (Cont'd)

	Carotene mg	Ascorbic Acid mg	Thiamin mg	Riboflavin mg	Niacin mg	Pyridoxine mg	Vitamin B12 mcg	Vitamin E mg
Swiss Steak								
unheated								
Precooked Frozen	NA	NA	0.15^{a} ±0.01	0.54^{b} ±0.06	16.58^{a} ±0.97	1.03^{a} ±0.12	6.37 ±0.73	1.3 ±0.3
Tray Pack	NA	NA	0.12^{b} ±0.01	0.65^{a} ±0.05	13.34^{b} ±1.19	1.01^{a} ±0.12	6.41 ±0.12	1.4 ±0.2
No. 10 Can	NA	NA	0.07^{c} ±0.02	0.59^{ab} ±0.06	12.82^{b} ±1.91	0.66^{b} ±0.11	7.17 ±0.79	1.6 ±0.3
heated								
Precooked Frozen	NA	NA	0.08^{a} ±0.03	0.69 ±0.03	14.42^{b} ±0.64	0.98^{a} ±0.08	5.65 ±0.54	3.3 ±0.1
Tray Pack	NA	NA	0.04^{b} ±0.02	0.70 ±0.04	15.72^{a} ±1.26	0.82^{b} ±0.04	4.60 ±1.40	2.8 ±0.2
No. 10 Can	NA	NA	0.01^{b} ±0.01	0.75 ±0.03	13.18^{b} ±0.76	0.59^{c} ±0.05	5.12 ±0.83	3.2 ±0.5

* The means followed by different letters are statistically different ($P \leq 0.05$) as determined by the Duncan's Multiple Range Test, N=5 (analyzed in duplicate).

NA = Not Analyzed.

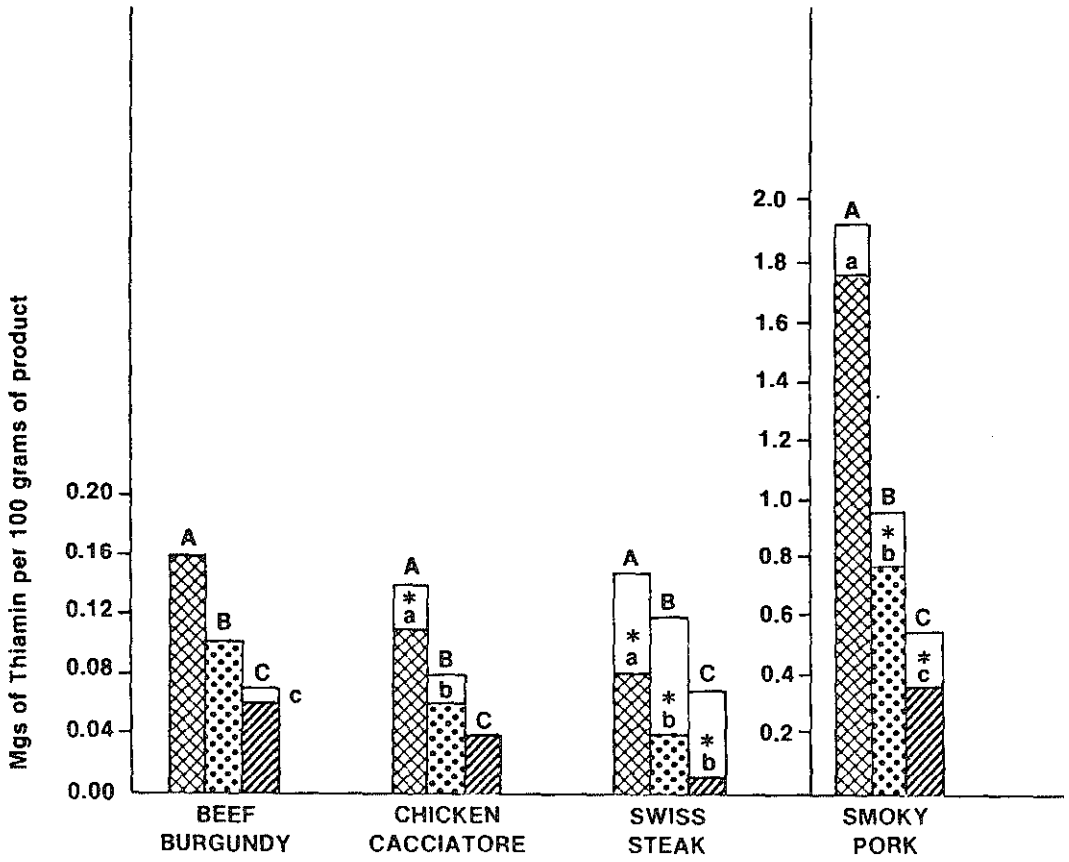
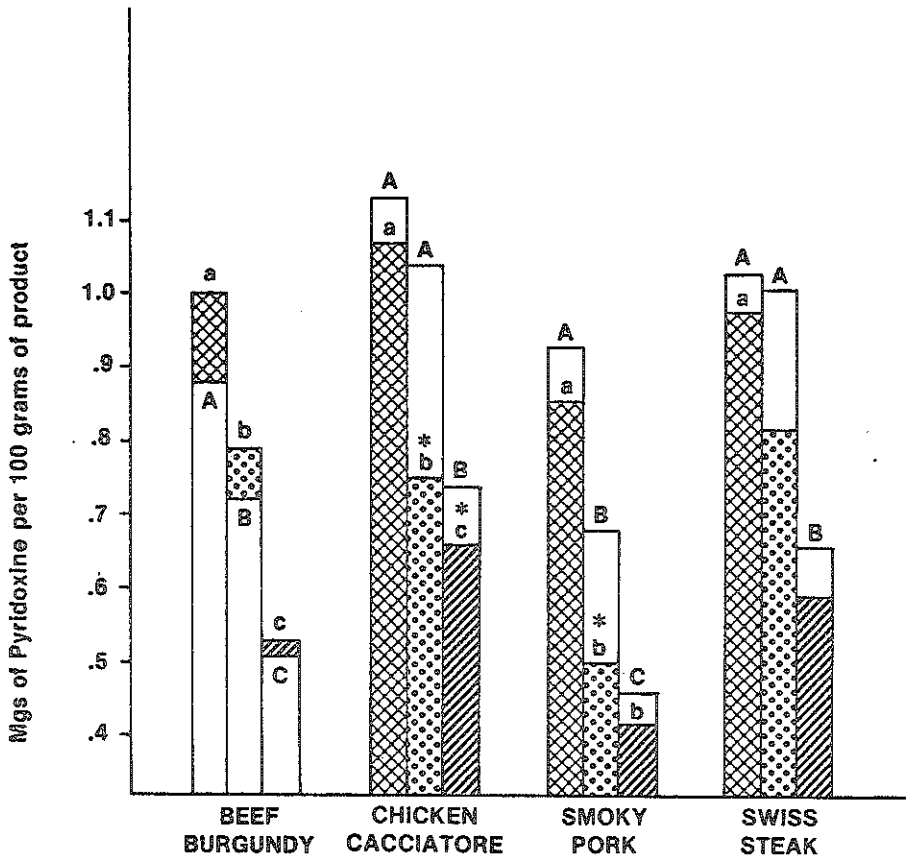


Figure 1. Thiamin content of unheated and heated precooked frozen, Tray Pack, and no. 10 can entrees (moisture and fat-free basis)



UNHEATED

PRECOOKED FROZEN (HEATED)

TRAY PACK (HEATED)

NO. 10 CAN (HEATED)

*: STATISTICALLY SIGNIFICANT DIFFERENCE ($p \leq 0.05$) BETWEEN HEATED AND UNHEATED SAMPLES

UNLIKE UPPER CASE LETTERS: STATISTICALLY SIGNFICANT DIFFERENCE BETWEEN UNHEATED PROCESSING AND PACKAGING VARIABLES

UNLIKE LOWER CASE LETTERS: STATISTICALLY SIGNIFICANT DIFFERENCE BETWEEN HEATED PROCESSING AND PACKAGING VARIABLES

Figure 2. Pyridoxine content of unheated and heated precooked frozen, Tray Pack, and no. 10 can entrees (moisture and fat-free basis)

heating, the pyridoxine levels averaged 73 percent and 56 percent, respectively, for the Tray Pack and the no. 10 can entrees, compared to the control. When the levels of thiamin in the Tray Pack and no. 10 can entrees were compared in the unheated and heated states, the Tray Packs before heating contained an average of 40% more thiamin than the no. 10 can entrees and after heating Tray Packs contained 50% more thiamin. Similarly compared, the average unheated Tray Pack retained 31% and the average heated Tray Pack 23% more pyridoxine than their no. 10 can counterparts. Thus, of the thermostabilization treatments tested, the Tray Pack package/process is more sparing of both thiamin and pyridoxine than is retorting in the no. 10 can.

TABLE 4. Comparison of Thiamin Content of Unheated and Heated Tray Pack and No. 10 Can Entrees as Percent of Amounts in Precooked Frozen Control Entrees

	Thiamin Content as % of Thiamin in Controls				
	Beef Burgundy	Chicken Cacciatore	Smoky Pork	Swiss Steak	Mean
Unheated					
Precooked Frozen (Control)	100	100	100	100	100
Tray Pack	62	57	49	80	62
No. 10 Can	44	29	28	47	37
Heated					
Precooked Frozen (Control)	100	100	100	100	100
Tray Pack	62	55	43	50	52
No. 10 Can	38	36	20	12	26

TABLE 5. Comparison of Pyridoxine Content of Unheated and Heated Tray Pack and No. 10 Can Entrees as Percent of Amounts in Precooked Frozen Control Entrees

	Pyridoxine Content as % of Pyridoxine Controls				
	Beef Burgundy	Chicken Cacciatore	Smoky Pork	Swiss Steak	Mean
Unheated					
Precooked Frozen (Control)	100	100	100	100	100
Tray Pack	83	92	73	98	86
No. 10 Can	59	65	49	64	59
Heated					
Precooked Frozen (Control)	100	100	100	100	100
Tray Pack	79	70	58	84	73
No. 10 Can	53	62	49	60	56

Heating Methods

Table 6 provides a comparison of the vitamin content (moisture and fat-free basis) of the Tray Pack entrees before heating and after heating, both in the oven and in a water bath. These data show that the forced-convection oven and the water bath methods of heating Tray Packs have comparable effects on the nutritional content of Tray Pack entrees. For three entrees, heating by either method resulted in significant losses of pyridoxine that ranged from 19 percent to 33 percent. Losses of thiamin occurred when Swiss Steak and Smoky Pork were heated; however, while the 19 percent loss that occurred in heating Smoky Pork in the oven was significant, the 12 percent loss that occurred when this product was heated in a water bath was not statistically significant. Thus, more data are needed to determine to what extent the thiamin content of Tray Packs is affected by heating.

Table 6. Vitamin Content of Tray Pack Entrees Before and After Heating by Two Different Methods (Mean ± Standard Deviation Per 100 Grams of Product, *Moisture and Fat-Free Basis)

	Carotene mg	Ascorbic Acid mg	Thiamin mg	Riboflavin mg	Niacin mg	Pyridoxine mg	Vitamin B12 mcg	Vitamin E mg
Beef Burgundy								
Unheated	NA	NA	0.10 ±0.01	0.67 ±0.05	10.66^{a} ±0.70	0.72 ±0.08	7.08^{a} ±0.27	3.0^{c} ±0.5
Heated in Oven	NA	NA	0.10 ±0.01	0.63 ±0.03	9.50^{b} ±0.58	0.79 ±0.11	5.30^{b} ±0.50	4.0^{b} ±0.6
Heated in Water Bath	NA	NA	0.10 ±0.02	0.69 ±0.04	9.50^{b} ±0.60	0.61 ±0.15	4.50^{c} ±0.45	6.5^{a} ±0.7
Chicken Cacciatore								
Unheated	0.288 ±0.056	30 ±11	0.08 ±0.03	0.41 ±0.04	25.30 ±1.42	1.04^{a} ±0.14	2.26^{a} ±0.17	1.3^{c} ±0.3
Heated in Oven	0.310 ±0.037	27 ± 4	0.06 ±0.01	0.37 ±0.04	27.14 ±0.70	0.75^{b} ±0.04	2.42^{a} ±0.04	1.9^{b} ±0.2
Heated in Water Bath	0.359 ±0.031	36 ± 7	0.05 ±0.01	0.39 ±0.03	27.28 ±2.36	0.70^{b} ±0.11	1.59^{b} ±0.13	2.7^{a} ±0.4
Smoky Pork								
Unheated	0.295^{b} ±0.018	NA	0.95^{a} ±0.13	1.00^{a} ±0.04	13.88 ±1.38	0.68^{a} ±0.03	3.67 ±0.20	2.1^{b} ±0.4
Heated in Oven	0.382^{a} ±0.062	NA	0.77^{b} ±0.11	0.92^{b} ±0.03	15.20 ±1.21	0.50^{b} ±0.11	3.35 ±0.19	2.4^{b} ±0.5
Heated in Water Bath	0.276^{b} ±0.029	NA	0.84^{ab} ±0.05	0.78^{c} ±0.07	15.42 ±2.47	0.55^{b} ±0.08	3.60 ±0.40	3.6^{a} ±0.4
Swiss Steak								
Unheated	NA	NA	0.12^{a} ±0.01	0.65^{b} ±0.05	13.34^{b} ±1.19	1.01^{a} ±0.12	6.41 ±0.12	1.4^{c} ±0.2
Heated in Oven	NA	NA	0.04^{b} ±0.02	0.70^{ab} ±0.04	15.72^{a} ±1.26	0.82^{b} ±0.04	4.60 ±1.40	2.8^{a} ±0.2
Heated in Water Bath	NA	NA	0.01^{b} ±0.01	0.77^{a} ±0.10	15.72^{a} ±0.92	0.82^{b} ±0.10	6.00 ±0.86	2.2^{b} ±0.4

* The means followed by different letters are statistically different ($P \leq 0.05$) as determined by the Duncan's Multiple Range Test, N=5 (analyzed in duplicate).
NA = Not Analyzed.

CONCLUSIONS

The nutritive content of the Tray Pack entrees prior to and after heating was determined. These values were then compared to those obtained in the precooked frozen and no. 10 can entrees - the current respective A and B Ration counterparts of the Tray Pack. From the relationship between these variables, the following can be concluded:

a. The Tray Pack thermostabilization process is more sparing of both thiamin and pyridoxine than is retorting in the no. 10 can.

b. The forced-convection oven method cited in this report and water bath method of heat treatment were equally effective in minimizing pyridoxine losses in Tray Packs.

RECOMMENDATIONS

A storage study needs to be conducted to determine if significant nutritive degradation occurs in Tray Pack entrees stored at various climatic temperatures. Furthermore, additional research needs to be done to determine the extent of nutritive losses which may occur when Tray Pack entrees are heated and held hot for various periods of time before being served.

This document reports research undertaken at the US Army Natick Research and Development Command and has been assigned No. NATICK/TR-86/012 in the series of reports approved for publication.

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3. R.G.D. Steel and J.H. Torrie, 1960. Principles and Procedures of Statistics, 1st Edition, McGraw-Hill.

4. D.A. Greenwood, B.W. Beadle, and H.R. Kraybill. Stability of Thiamin to Heat. II. Effect of meat-curing ingredients in aqueous solutions and in meat. J. Biol. Chem., 149, 349, 1943.

5. J. Szczeblowski and E. Nebesky. Tray Pack Foods. How Ready are Ready-to-serve Foods? International Symposium, August 23-24, 1977, Karlsruhe, Germany, p. 90.

APPENDICES

A. Formulas and Processing Procedures for NRDC Produced Entrees

B. Methods of Analyses[1]

C. Net Weight Change and Nutritive Content

D. Fatty Acid Content of Unheated Precooked Frozen, Tray Pack, and No. 10 Can Entrees as Percent of Total Fatty Acids (N=3)*

Appendix A. Formulas and Processing Procedures for NRDEC* Produced Entrees

1. Beef Burgundy with Rotini

Gravy formula:

	Percent
Carrots, frozen, dice	10.00
Dehydrated onion pieces, rehydrated	10.00
Mushrooms, pieces, canned	9.50
Tomato paste, 26% solids	4.00
Flour	1.50
Burgundy wine flavor, Vie-Del	3.50
Margarine	1.50
Hydrolyzed vegetable protein, Nestles 4BE	1.00
Starch*	2.50
Vinegar, cider, 40 grain	1.00
Salt	.75
Monosodium glutamate	.75
Sugar, white	.60
Celery seed, ground	.09
Black pepper	.03
Garlic powder	.02
Broth and water, 50/50	53.26
	100.00

*For heat processed products, "Clearjel" (National Starch) was used. For the precooked frozen product, "Col-Flo," same vendor, was substituted.

Procedure

All ingredients except starch, flour, carrots, burgundy flavor, and a small portion of the water were placed in a steam-jacketed kettle with agitator. A starch-flour slurry was prepared with the remaining water and added when the temperature reaches 71°C (160°F). Heating continued until the temperature reached 82°C (180°F), at which time the carrots and burgundy flavor were added. Volume was adjusted with water to original formula weight and sauce was held hot until filling (less than one hour).

* NRDEC Notebook No. 7058, 27 May 1977, pp. 6, 10, 13, and 16

Appendix A (con'd)

Meat Component

Frozen diced beef was used. For number 10 and tray can packs, beef dices were browned in a steam-jacketed kettle until all surfaces had changed color. Depending upon batch size sufficient water was added to extract broth and provide one-half of liquid requirement for the gravy. For the precooked frozen product, dices were placed with sufficient water for the broth requirement, into field pans. Pans were placed in a 177°C (350°F) bakery rotary oven and the dices cooked to finish. The oven was stopped intermittently and the cubes stirred to prevent sticking/scorching.

Fill Proportions, All Containers

	Ounces	Percent
Beef dice	35.0	33.0
Rotini, water blanched to double weight	11.0	10.4
Gravy	60.0	56.6
Total	106.0	100.0

Retorting/Freezing

Approximate fill temperature for retorted products was 49°C (120°F). Tray Packs were closed on a Callahan-AMS Machinery Co., 227 SV Vacumn Sealer. Number 10 cans were closed on an American Can Co., No. 1 Pacific SV Closing Machine. Both Tray Packs and number 10 cans were still processed in a 121°C (250°F) horizontal steam-air retort at 17-68 PSI equipped with water spray cooling. Process times were: Tray Packs - 64 minutes; number 10 cans - 225 minutes. For filled plain foil pans containing product for freezing, an Elks Plus Machinery, Inc., closing machine was used to crimp on lids. These pans were chilled, then placed in a -32°C (-20°F) blast freezer for approximately 18 hours. Pans were then moved to a -18°C (0°F) freezer for storage.

Appendix A (con'd)

2. Chicken Cacciatore

Gravy formula:

	Percent
Monosodium glumate	1.00
Salt	1.00
Tomatoes, whole	12.00
Tomato paste, 26% solids	3.00
Starch*	3.00
Flour	1.00
Dehydrated onion pieces, rehydrated	1.91
Sugar, white	0.75
Cinnamon	.007
Stock	71.393
Burgundy wine flavor, Vie-Del	3.00
Chicken fat & emulsified turkey skins**	1.79
Garlic powder	0.02
Rosemary, ground	0.05
Celery seed, ground	0.05
Black pepper	0.03
	100.00

*For heat processed products, "Clearjel" was used; for precooked frozen, "Col-Flo."

**Emulsified with water in Waring Blender until skin was completely marcerated.

Procedure

All ingredients except starch, flour, burgundy flavor and a portion of water for slurry production were placed in a steam-jacketed kettle with agitator. The starch-flour slurry was added when the temperature reached 71°C (160°F). Heating continued to 82° (160°F) and the burgundy flavor was added. Sauce was held hot for filling (less than one hour).

Meat Component

Frozen turkey breasts, bone-in, were used. The breasts were placed in roasting pans with approximately one and one-half quarts water, and covered with foil. For both precooked frozen and heat processed products, pans were placed in steamer and steamed to an internal temperature of 77°C (171°F), cooled, boned and handcut into dices.

Appendix A (con'd)

Fill Proportions

	Ounces	Percent
Turkey	42.5	40.1
Gravy	63.5	59.9

Approximate fill temperature for retorted products was 49°C (120°F). Product for freezing was chilled before placement in blast freezer.

Retorting/Freezing

Closing machines and the retort procedure used for Tray Packs and no. 10 cans were as described for the beef burgundy item. Process times were: Tray Pack - 70 minutes; number 10 cans - 232 minutes. Procedure for the frozen product was also as described for beef burgundy.

Additional Note:

Runs were made starting with solidly frozen breasts and with previously thawed breasts. When starting with frozen breasts, average yield of cooked meat minus skins was 51.3% (3 runs); with previously thawed breasts, the average of four runs was 54.2%. Extent of drippage from thawing was not recorded but could account for the apparent increase in yield.

3. Smoky Pork

Gravy formula:

	Percent
Red peppers	0.50
Tomato paste, 26% solids	8.86
Brown sugar	3.59
Starch*	3.25
Dehydrated onion pieces, rehydrated	1.75
Cider vinegar, 40 grain	3.25
Salt	0.80
Monosodium glutamate	0.25
Liquid smoke, Red Arron	0.50
Mustard, dry	0.02
Hot sauce	0.01
Garlic powder	0.03
Allspice	0.006
Chili powder	0.05
Sugar, white	1.00
Black pepper	0.02
Flour	1.75
Cloves	0.004
Pork broth & water	94.36
	100.000

*For heat processed products, "Clearjel" was used; for the precooked frozen product, "Col-Flo" at 0.25% lower level was used.

Appendix A (con'd)

Procedure

All ingredients except starch, flour, smoke flavor, and an aliquot of water for starch-flour slurry preparation were combined in a steam-jacketed kettle with agitator and heated to 71°C (160°F). The starch-flour slurry was added and heating continued to 82° (180°F) at which time the smoke flavor was added.

Meat Component

Frozen boneless butts were used. Due to high fat content, the resulting pork dice was retrimmed. Identical procedures to those used for meat component of the Beef Burgundy items were followed, both for heat processed and precooked frozen products. Meat yield, frozen butts to cooked cubes, was 60.3%.

Fill Proportions, All Containers

Pork dice were filled into containers first, then gravy. Prior to filling the frozen product, both meat and gravy components were chilled. Fill temperature for retorted products was approximately 49°C (120°F).

Proportions

	Ounces	Percent
Pork dice	53	50.0
Gravy	53	50.0
Total	106	100.0

Retorting/Freezing

Closing machines and the retort procedure used were as described for the beef burgundy item. Process times were: Tray Pack - 62 minutes; number 10 can - 223 minutes. Procedure for the frozen product was also as described for beef burgundy.

Appendix A (con'd)

4. Swiss Steak

Gravy formula:

	Percent
Celery seed, ground	0.10
Brown sugar	0.20
Garlic powder	0.31
Dehydrated onion pieces, rehydrated	9.71
Black pepper	0.07
Salt	1.23
Worcestershire sauce	1.84
Hydrolyzed vegetable protein, Nestles 4BE	0.92
Flour	1.50
Starch*	3.00
Beef broth & water, 50/50	81.12
	100.00

*For heat processed products, "Cleargel" was used; for the precooked frozen product, "Col-Flo" was used.

Procedure

All ingredients except starch, flour, and a small amount of water for slurry preparation were combined in a steam-jacketed kettle. When the temperature reached 71°C (160°F), the starch-flour slurry was added and heating continued to 82° (180°F). Sauce was held hot for filling (less than one hour).

Meat Component

Swiss steaks, boneless, frozen choice, were used. They were placed in roasting pans while still frozen and approximately two quarts water added per pan for broth production. For heat processed products, pans were covered with foil and placed in a steamer and steamed until the surface pink color had disappeared (about 20 minutes). Average yield was 70.4%. For the precooked frozen product, pans were placed in a 260°C (500°F) rotary oven and baked until pieces were browned on both sides. After browning, pans were placed in the steamer for one hour to cook to finish. Average yields, 52.3%.

Filling Proportions, All Containers

	Ounces	Percent
Swiss Steak	46.25	44.3
Gravy	58.00	55.7
Total	104.25	100.0

Fill weights for frozen product were the same as for heat processed products although the meat yield for frozen product was lower. Approximate fill temperature 49°C (120°F) for retorted products. Product for freezing was chilled before placement in blast freezer.

Retorting/Freezing

Closing machines and the retort procedure used were as described for the beef burgundy item. Process times were: Tray Pack - 60 minutes; number 10 can - 224 minutes. Procedure for the frozen product was also as described for beef burgundy.

APPENDIX B

Methods of Analyses[1]

Association of Official Analytical Chemists (AOAC) Methods, 13th Edition (1980)[2]

Assay	Reference
Moisture	24.003
Total Fat	24.005
Protein	2.057
Crude Fiber	7.065
Ash	14.006
Phosphorus	2.021
Chloride as NaCl	18.034
Cholesterol	14.149

Atomic absorption spectrophotometer[3]

Calcium	AASP
Iron	AASP
Sodium	AASP
Potassium	AASP
Magnesium	AASP

Other

Iodine	Anal. Chemica Acta 10, 78 (1954)[4]
Fatty Acid Profile	28.057

Methods of Vitamin Assay - Third Edition (1966)[5]

Assay	Pages
Vitamin A	70-79
Carotene	104-115
Thiamin	127-140
Riboflavin	158-164
Niacin	172-176
Pyridoxine	212-219
Vitamin E[6,7]	366-396
Ascorbic Acid	299-306
Folacin	227-234
Vitamin B12	262-270

Appendix B (con'd)

[1]Horwitz, W. (ed.) Official methods of analysis of the assoc. of official analytical chemists, AOAC, 11th Ed. 1970 (stipulated in contract No.'s DAAK03-75-C-0015 and DAAK03-74-D-0001).

[2]Ibid., 13th Ed. 1980.

[3]Perkin-Elmer, Analytical methods for atomic absorption spectrophotometry, a technical manual, 1964

[4]Anal. Chemica Acta, 10, 78 (1954).

[5]Association of Vitamin Chemists, Inc., Methods of vitamin assay, Third Edition, 1966.

[6]Acta Chem. Scand., 11, 34 (1957).

[7]J. Chromato. 27, 96 (1967).

APPENDIX C

Net Weight Change and Nutritive Content

TABLE C-1. Net Weight Before and After Heating and Weight Loss of Precooked Frozen, Tray Pack and No. 10 Can Entrees (Mean ± Standard Deviation in Grams)

	Precooked Frozen	Tray Pack	No. 10 Cans
Beef Burgundy			
Before heating	2984 ± 22	2872 ± 30	2940 ± 12
After heating	2853 ± 23	2868 ± 31	2742 ± 56
Net Loss	131	4	198
Chicken Cacciatore			
Before heating	2980 ± 16	2838 ± 38	2931 ± 24
After heating	2833 ± 23	2833 ± 69	2756 ± 25
Net Loss	147	5	175
Smoky Pork			
Before heating	2991 ± 7	2894 ± 35	2889 ± 153
After heating	2807 ± 33	2868 ± 36	2749 ± 48
Net Loss	184	26	140
Swiss Steak			
Before heating	2915 ± 45	2854 ± 46	2863 ± 28
After heating	2678 ± 36	2775 ± 16	2698 ± 41
Net Loss	237	79	165

TABLE C-2. Nutritive Analyses of Unheated and Heated Precooked Frozen, Tray Pack, and No. 10 Can Entrees (Mean ± Standard Deviation per 100 Grams of Product As is Basis)

BEEF BURGUNDY - UNHEATED

		Precooked Frozen	Tray Pack	No. 10 Cans
PROXIMATES:				
Moisture	g	73.0 ± 1.50	74.4 ± 1.73	73.1 ± 1.40
Protein	g	14.2 ± 1.76	12.5 ± 1.06	11.4 ± 0.26
Fat	g	5.66 ± 0.703	5.46 ± 0.832	5.21 ± 0.747
Ash	g	1.70 ± 0.065	1.60 ± 0.050	1.60 ± 0.061
MINERALS:				
Calcium	mg	13 ± 0.6	14 ± 1.5	15 ± 1.2
Phosphorus	mg	136 ± 2.5	117 ± 2.3	117 ± 2.6
Iron	mg	2.16 ± 0.098	1.90 ± 0.199	2.05 ± 0.101
Sodium	mg	430 ± 5.0	450 ± 32.9	422 ± 15.9
Potassium	mg	262 ± 10.8	222 ± 3.5	224 ± 27.6
Magnesium	mg	20 ± 0.0	18 ± 0.0	18 ± 0.6
Chloride	mg	0.81 ± 0.000	0.83 ± 0.015	0.82 ± 0.015
VITAMINS:				
Thiamin	mg	0.035 ± 0.0036	0.020 ± 0.0038	0.015 ± 0.0024
Riboflavin	mg	0.151 ± 0.0089	0.136 ± 0.0139	0.136 ± 0.0116
Niacin	mg	2.50 ± 0.173	2.14 ± 0.055	2.22 ± 0.084
Pyridoxine	mg	0.19 ± 0.013	0.14 ± 0.013	0.11 ± 0.008
Vitamin B12	mcg	1.15 ± 0.086	1.42 ± 0.060	1.26 ± 0.214
Vitamin E	mg	1.0 ± 0.09	0.6 ± 0.12	0.0 ± 0.0
LIPIDS:				
Total fatty acids*	g	5.09	4.91	4.69
FATTY ACIDS:				
14:0 Myristic	g	0.10	0.09	0.10
14:1 Myristoleic	g	0.02	0.02	0.02
16:0 Palmitic	g	1.24	1.19	1.17
16:1 Palmitoleic	g	0.23	0.19	0.24
16:2 Hexadecadienoic	g	0.04	0.04	0.04
18:0 Stearic	g	0.63	0.68	0.58
18:1 Oleic	g	2.52	2.40	2.29
18:2 Linoleic	g	0.27	0.27	0.22
18:3 Linolenic	g	0.05	0.04	0.03
Cholesterol	mg	50 ± 5.1	47 ± 6.4	40 ± 4.0

*Total fatty acids are assumed to be 90 percent of total fat content.[1]

Table C-2 (con'd)

BEEF BURGUNDY - HEATED to 74°C (165°F) in Forced-Convection Oven

MOISTURE AND FAT:		Precooked Frozen	Tray Pack	No. 10 Cans
Moisture	g	71.9 ± 2.02	73.0 ± 1.73	69.7 ± 1.61
Fat	g	4.9 ± 0.38	6.0 ± 1.04	7.1 ± 0.99
VITAMINS:				
Thiamin	mg	0.037± 0.0036	0.020± 0.0018	0.014± 0.0034
Riboflavin	mg	0.170± 0.0123	0.133± 0.0079	0.143± 0.0053
Niacin	mg	2.5 ± 0.22	2.0 ± 0.14	2.1 ± 0.22
Pyridoxine	mg	0.23 ± 0.041	0.16 ± 0.018	0.12 ± 0.0013
Vitamin B12	mcg	1.35 ± 0.056	1.1 ± 0.060	1.26 ± 0.100
Vitamin E	mg	0.7 ± 0.11	0.8 ± 0.09	0.8 ± 0.15

CHICKEN CACCIATORE - UNHEATED

PROXIMATES:				
Moisture	g	78.0 ± 0.41	79.8 ± 1.22	79.3 ± 0.54
Protein	g	14.9 ± 1.01	13.8 ± 1.47	14.2 ± 0.35
Fat	g	1.38 ± 0.077	1.06 ± 0.326	1.30 ± 0.212
Ash	g	1.55 ± 0.012	1.42 ± 0.072	1.49 ± 0.025
MINERALS:				
Calcium	mg	16 ± 0.6	14 ± 0.0	17 ± 2.6
Phosphorus	mg	89 ± 21.9	110 ± 5.3	122 ± 4.4
Iron	mg	0.74 ± 0.197	1.07 ± 0.366	0.76 ± 0.021
Sodium	mg	339 ± 29.5	314 ± 24.2	340 ± 15.5
Potassium	mg	232 ± 5.9	212 ± 6.6	221 ± 11.4
Magnesium	mg	19 ± 0.6	18 ± 0.0	18 ± 0.0
Chloride	mg	0.75 ± 0.025	0.72 ± 0.006	0.74 ± 0.006
VITAMINS:				
Carotene	mg	0.039± 0.0038	0.055± 0.0088	0.047± 0.0061
Ascorbic Acid	mg	2 ± 0.4	6 ± 2.2	9 ± 1.5
Thiamin	mg	0.029± 0.0028	0.016± 0.0048	0.009± 0.0011
Riboflavin	mg	0.093± 0.0054	0.077± 0.0084	0.070± 0.0019
Niacin	mg	5.1 ± 0.27	4.8 ± 0.27	4.6 ± 0.09
Pyridoxine	mg	0.23 ± 0.015	0.20 ± 0.019	0.14 ± 0.013
Vitamin B12	mcg	0.53 ± 0.060	0.43 ± 0.044	0.45 ± 0.053
Vitamin E	mg	0.3 ± 0.11	0.3 ± 0.05	0.3 ± 0.08
LIPIDS:				
Total fatty acids*	g	1.24	0.95	1.17

*Total fatty acids are assumed to be 90 percent of total fat content.[1]

Table C-2 (con'd)

CHICKEN CACCIATORE - UNHEATED (con'd)

FATTY ACIDS:		Precooked Frozen	Tray Pack	No. 10 Cans
14:0 Myristic	g	0.01	0.00	0.00
16:0 Palmitic	g	0.32	0.25	0.30
16:1 Palmitoleic	g	0.08	0.06	0.09
18:0 Stearic	g	0.08	0.06	0.08
18:1 Oleic	g	0.40	0.29	0.39
18:2 Linoleic	g	0.33	0.26	0.30
18:3 Linolenic	g	0.02	0.01	0.01
Cholesterol	mg	39 ± 1.2	33 ± 3.0	40 ± 5.3

CHICKEN CACCIATORE - HEATED TO 74°C (165°F) in Forced-Convection Oven

MOISTURE AND FAT:				
Moisture	g	76.3 ± 0.44	79.0 ± 0.74	79.5 ± 0.54
Fat	g	1.41 ± 0.088	1.08 ± 0.280	1.09 ± 0.161
VITAMINS:				
Carotene	mg	0.066± 0.0055	0.062± 0.0059	0.070± 0.0039
Ascorbic Acid	mg	7.0 ± 1.8	5.0 ± 0.9	9.0 ± 1.3
Thiamin	mg	0.025± 0.0030	0.012± 0.0023	0.007± 0.0008
Riboflavin	mg	0.093± 0.0066	0.073± 0.0084	0.070± 0.0072
Niacin	mg	5.8 ± 0.38	5.4 ± 0.20	5.4 ± 0.17
Pyridoxine	mg	0.24 ± 0.023	0.15 ± 0.010	0.13 ± 0.008
Vitamin B12	mcg	0.59 ± 0.024	0.48 ± 0.073	0.39 ± 0.052
Vitamin E	mg	0.5 ± 0.09	0.4 ± 10.04	0.6 ± 0.00

Table C-2 (con'd)

SMOKY PORK - UNHEATED

		Precooked Frozen	Tray Pack	No. 10 Cans
PROXIMATES:				
Moisture	g	71.1 ± 0.48	67.5 ± 2.00	66.3 ± 2.57
Protein	g	16.3 ± 0.53	16.4 ± 0.65	18.5 ± 1.56
Fat	g	6.1 ± 1.17	10.7 ± 1.92	10.7 ± 2.18
Ash	g	1.29 ± 0.020	1.21 ± 0.046	1.28 ± 0.0049
MINERALS:				
Calcium	mg	12.7 ± 1.16	14.0 ± 3.46	12.7 ± 0.58
Phosphorus	mg	131 ± 22.8	117 ± 17.8	159 ± 6.0
Iron	mg	1.07 ± 0.044	1.29 ± 0.079	1.85 ± 0.175
Sodium	mg	242 ± 1.5	251 ± 14.1	239 ± 5.0
Potassium	mg	305 ± 6.8	266 ± 11.6	312 ± 22.5
Magnesium	mg	21 ± 0.0	18 ± 0.6	21 ± 1.2
Chloride	mg	0.50 ± 0.030	0.53 ± 0.017	0.51 ± 0.000
VITAMINS:				
Carotene	mg	0.072± 0.0041	0.064± 0.0039	0.060± 0.0046
Thiamin	mg	0.44 ± 0.018	0.21 ± 0.025	0.13 ± 0.006
Riboflavin	mg	0.22 ± 0.015	0.22 ± 0.008	0.23 ± 0.003
Niacin	mg	3.50 ± 0.245	3.02 ± 0.249	3.56 ± 0.207
Pyridoxine	mg	0.21 ± 0.018	0.15 ± 0.008	0.11 ± 0.009
Vitamin B12	mcg	0.72 ± 0.028	0.80 ± 0.028	0.89 ± 0.034
Vitamin E	mg	0.5 ± 0.01	0.5 ± 0.01	0.5 ± 0.00
LIPIDS:				
Total fatty acids*	mg	5.45	9.61	9.61
FATTY ACIDS:				
14:0 Myristic	g	0.04	0.10	0.10
16:0 Palmitic	g	1.36	2.40	2.40
16:1 Palmitoleic	g	0.16	0.30	0.30
16:2 Hexadecadienoic	g	0.01	0.02	0.02
18:0 Stearic	g	0.66	1.23	1.23
18:1 Oleic	g	2.75	4.67	4.70
18:2 Linoleic	g	0.44	0.82	0.77
18:3 Linolenic	g	0.04	0.04	0.05
Cholesterol	mg	85 ± 3.0	75 ± 2.3	84 ± 1.2

*Total fatty acids are assumed to be 90 percent of total fat content.[1]

Table C-2 (con'd)

SMOKY PORK - HEATED to 74°C (165°F) in Forced-Convection Oven

MOISTURE AND FAT:		Precooked Frozen	Tray Pack	No. 10 Cans
Moisture	g	69.9 ± 0.70	67.0 ± 2.29	69.0 ± 0.65
Fat	g	5.8 ± 0.93	12.5 ± 2.09	9.8 ± 0.68
VITAMINS:				
Carotene	mg	0.084± 0.0095	0.079± 0.0137	0.067± 0.0100
Thiamin	mg	0.43 ± 0.042	0.16 ± 0.021	0.08 ± 0.019
Riboflavin	mg	0.20 ± 0.004	0.19 ± 0.012	0.21 ± 0.004
Niacin	mg	3.64 ± 0.336	3.12 ± 0.18	3.64 ± 0.619
Pyridoxine	mg	0.21 ± 0.019	0.10 ± 0.018	0.09 ± 0.008
Vitamin B12	mcg	0.62 ± 0.052	0.69 ± 0.021	0.71 ± 0.065
Vitamin E	mg	0.7 ± 0.09	0.5 ± 0.10	0.6 ± 0.11

SWISS STEAK - UNHEATED

PROXIMATES:				
Moisture	g	68.7 ± 1.41	72.9 ± 1.87	73.5 ± 2.12
Protein	g	21.0 ± 1.27	17.5 ± 2.31	19.0 ± 0.90
Fat	g	7.59 ± 1.064	5.46 ± 1.532	4.63 ± 0.314
Ash	g	1.72 ± 0.061	1.77 ± 0.035	1.58 ± 0.035
MINERALS:				
Calcium	mg	9.7 ± 0.58	10.3 ± 1.53	10.0 ± 0.00
Phosphorus	mg	178 ± 14.5	152 ± 2.6	142 ± 3.6
Iron	mg	2.04 ± 0.047	2.00 ± 0.185	1.98 ± 0.162
Sodium	mg	472 ± 12.6	474 ± 22.0	459 ± 5.3
Potassium	mg	286 ± 23.0	254 ± 8.7	217 ± 11.6
Magnesium	mg	21.0 ± 1.00	19.0 ± 1.00	17.3 ± 0.58
Chloride	mg	0.96 ± 0.023	1.00 ± 0.006	0.94 ± 0.036
VITAMINS:				
Thiamin	mg	0.036± 0.0026	0.025± 0.0025	0.015± 0.0037
Riboflavin	mg	0.128± 0.0146	0.140± 0.0072	0.130± 0.0220
Niacin	mg	3.94 ± 0.0270	2.88 ± 0.238	2.78 ± 0.250
Pyridoxine	mg	0.24 ± 0.034	0.22 ± 0.031	0.14 ± 0.015
Vitamin B12	mcg	1.5 ± 0.14	1.38 ± 0.189	1.56 ± 0.119
Vitamin E	mg	0.3 ± 0.084	0.3 ± 0.00	0.3 ± 0.09
LIPIDS:				
Total fatty acids*	g	6.83	4.91	4.17

*Total fatty acids are assumed to be 90 percent of total fat content.[1]

Table C-2 (con'd)

SWISS STEAK - UNHEATED (con'd)

FATTY ACIDS:		Precooked Frozen	Tray Pack	No. 10 Cans
14:0 Myristic	g	0.23	0.14	0.09
14:1 Myristoleic	g	0.08	0.03	0.02
16:0 Palmitic	g	1.84	1.36	1.07
16:1 Palmitoleic	g	0.43	0.24	0.19
16:2 Hexadecadienoic	g	0.09	0.05	0.05
18:0 Stearic	g	0.80	0.63	0.57
18:1 Oleic	g	3.24	2.36	2.09
18:2 Linoleic	g	0.10	0.09	0.09
Cholesterol	mg	69 ± 3.8	62 ± 6.6	68 ± 9.1

SWISS STEAK - HEATED to 74°C (165°F) in Forced-Convection Oven

MOISTURE AND FAT:				
Moisture	g	69.2 ± 1.85	72.7 ± 2.04	73.6 ± 0.78
Fat	g	6.4 ± 1.39	5.4 ± 1.65	4.3 ± 0.38
VITAMINS:				
Thiamin	mg	0.019± 0.0061	0.008± 0.0049	0.02 ± 0.0015
Riboflavin	mg	0.169± 0.0049	0.154± 0.0126	0.166± 0.0062
Niacin	mg	3.5 ± 0.16	3.4 ± 0.27	2.9 ± 0.11
Pyridoxine	mg	0.24 ± 0.016	0.18 ± 0.004	0.13 ± 0.010
Vitamin B12	mcg	1.4 ± 0.15	1.0 ± 0.32	1.1 ± 0.19
Vitamin E	mg	0.8 ± 0.00	0.6 ± 0.04	0.7 ± 0.10

[1]Murphy, E.W., L. Page, and P.D. Koons. Lipid components of type A school lunches. J. Am. Diet. Assoc., 56(6):504, 1970.

APPENDIX D

Fatty Acid Content of Unheated Precooked Frozen, Tray Pack, and No. 10 Can Entrees as Percent of Total Fatty Acids (N=3)*

BEEF BURGUNDY	Precooked Frozen	Tray Pack	No. 10 Cans
14:0 Myristic	2.0 ± 0.13	1.9 ± 0.23	2.2 ± 0.06
14:1 Myristoleic	0.3 ± 0.06	0.4 ± 0.10	0.4 ± 0.06
16:0 Palmitic	24.4 ± 0.28	24.3 ± 0.60	25.0 ± 0.03
16:1 Palmitoleic	4.5 ± 0.38	3.8 ± 0.80	5.0 ± 0.25
16:2 Hexadecadienoic	0.7 ± 0.12	0.8 ± 0.17	0.8 ± 0.12
18:0 Stearic	12.3[b] ± 0.29	13.8[a] ± 0.83	12.4[b] ± 0.25
18:1 Oleic	49.5 ± 0.44	48.9 ± 0.60	48.8 ± 0.38
18:2 Linoleic	5.3 ± 0.86	5.5 ± 0.44	4.8 ± 0.12
18:3 Linolenic	**1.0 ± 0.42	≠0.9 ± 0.42	0.7 ± 0.26
20:0 Arachidic	---	---	---
20:1 Gadoleic	---	---	---
CHICKEN CACCIATORE			
14:0 Myristic	0.5 ± 0.15	0.3 ± 0.06	0.4 ± 0.02
14:1 Myristoleic	---	---	---
16:0 Palmitic	26.1 ± 0.68	26.6 ± 0.26	25.6 ± 1.01
16:1 Palmitoleic	6.8 ± 0.76	6.8 ± 0.32	7.4 ± 1.15
16:2 Hexadecadienoic	---	---	---
18:0 Stearic	6.6 ± 0.45	6.8 ± 0.56	6.8 ± 0.61
18:1 Oleic	32.2[ab] ± 1.27	30.7[a] ± 0.87	33.1[b] ± 0.81
18:2 Linoleic	26.6 ± 0.47	27.6 ± 0.06	25.8 ± 0.82
18:3 Linolenic	**1.3 ± 0.20	**1.2 ± 0.36	**1.1 ± 0.15
20:0 Arachidic	---	≠	≠
20:1 Gadoleic	**	**	**
SMOKY PORK			
14:0 Myristic	0.8 ± 0.05	1.0 ± 0.12	1.0 ± 0.10
14:1 Myristoleic	---	---	---
16:0 Palmitic	24.9 ± 0.05	25.0 ± 0.46	25.0 ± 0.09
16:1 Palmitoleic	2.9 ± 0.18	3.1 ± 0.15	3.1 ± 0.20
16:2 Hexadecadienoic	≠0.2 ± 0.00	0.2 ± 0.03	0.2 ± 0.03
18:0 Stearic	12.2 ± 0.55	12.8 ± 0.15	12.8 ± 0.42
18:1 Oleic	50.4 ± 0.80	48.6 ± 0.53	48.9 ± 0.49
18:2 Linoleic	8.0 ± 0.50	8.5 ± 0.38	8.0 ± 0.51
18:3 Linolenic	**0.7 ± 0.45	≠0.4 ± 0.14	0.5 ± 0.12
20:0 Arachidic	---	---	---
20:1 Gadoleic	---	0.6 ± 0.05	0.6 ± 0.23

Appendix D (con'd)

SWISS STEAK	Precooked Frozen	Tray Pack	No. 10 Cans
14:0 Myristic	$3.4^{a} \pm 0.60$	$2.9^{ab} \pm 0.56$	$2.1^{b} \pm 0.16$
14:1 Myristoleic	$1.2^{a} \pm 0.18$	$0.6^{b} \pm 0.18$	$0.4^{b} \pm 0.09$
16:0 Palmitic	27.0 ± 1.18	27.6 ± 1.13	25.6 ± 0.77
16:1 Palmitoleic	$6.3^{a} \pm 0.73$	$4.9^{b} \pm 0.45$	$4.5^{b} \pm 0.59$
16:2 Hexadecadienoic	1.3 ± 0.43	1.0 ± 0.05	1.1 ± 0.18
18:0 Stearic	11.8 ± 1.44	13.0 ± 1.07	13.6 ± 0.76
18:1 Oleic	47.4 ± 1.86	48.1 ± 1.69	50.0 ± 1.32
18:2 Linoleic	1.5 ± 0.15	1.8 ± 0.32	2.2 ± 0.46
18:3 Linolenic	≠	≠	≠
20:0 Arachidic	---	---	---
20:1 Gadoleic	≠	≠	≠

*Means in the same row followed by different letters are statistically significantly different ($P \leq 0.05$) as determined by Duncan's Multiple Range Test.

**Linolenic (18:3) and Gadoleic (20:1) analyzed together.

≠ N=2
≠ Variable data (less than 1 percent).